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Materials chemistry and applications

Valorization of waste cooking oils through conversion processes catalyzed by choline hydroxide

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The world is facing great challenges due to the reduction of unrecoverable fossil fuels, the dependence on its industry, the increase in energy consumption and the increase in environmental pollution. A large amount of energy needs across the world is met by fossil fuels (petrochemical, coal, and natural gas).[1,2]
The development of renewable energy resources is necessary to create the need for other alternatives to fossil fuels.[3] Biodiesel, as a renewable energy resource, is used as an alternative fuel in diesel engines.[2] Biodiesel can be defined as mono-alkyl esters of long-chain fatty acids produced from vegetable or animal oils and alcohol with or without a catalyst. It can be produced by esterification of fatty acids or transesterification of triglycerides with short chain alcohols, such as methanol and ethanol. Methanol is used mainly due to its lower cost compared with other alcohols, so biodiesel most commonly refers to fatty acid methyl esters (FAME).[1,3]
The raw material is obtained from edible and non-edible oil sources including palm oil, jatropha oil, mustard oil, beauty leaf oil, microalgae oil, rubber seed oil, mahua oil, animal fats, waste cooking oil, can be used for biodiesel synthesis.[2,3]
The effective way to sustain biodiesel productivity is to reduce dependence on edible raw materials and oil. This current study focused on the use of waste cooking oil (WCO) to produce biodiesel. The processing of WCO waste facilitates a consistent supply of raw material compared to competition with edible raw materials, which are more valuable as part of consumable food items. Thus, the use of WCO as a low-grade raw material for the synthesis of renewable fuel ensures price stability and process sustainability.[4]
Ionic liquids were initially introduced as alternative green reaction media due to their unique physicochemical properties such as non-volatility, non-flammability, thermal stability, and controlled miscibility. At present, these are extensively used in controlling the reaction as catalysts. Synthesis of biodiesel using ILs as a catalyst is a promising pathway to an eco-friendly production.[1]
The objective of this work is to study Choline Hydroxide as a catalyst in esterification/transesterification reaction with methanol to produce biodiesel from waste cooking oil samples.
A numerical optimization method was devised using the Design-Expert 11 software, by the generation of a Box-Benhken Design (BBD), applied for a Response Surface Methodology (RSM) analysis. Hence, a matrix with four factors at three levels (-1 0 1) was constructed. The selected factors were the percentage of catalyst (2wt%, 4wt% and 6wt%), the oil/methanol molar ratio (1:5,1:10 and 1:15), the reaction temperature (55ºC, 60ºC and 65ºC) and the incorporation of oleic acid (0wt%, 1wt% and 2wt%) for an artificial control of the raw material acidity. Through this strategy, 27 runs were established in order to quantify statistically the influence of each factor in the response: the FAME content of the produced biodiesel. A constant reaction time of 30 minutes was maintained during all runs.

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